Agricultural Efficiency

Team Managers
Anthony J. Brigantic
Lewis E. Winstead, Jr.

Team Members
Walter Adams III
Alana M. Barnes
Nathan Burgess
Robert S. Patrick
Marissa L. Tuck
Garry V. Wieneke, Jr.

Mentors
Michael Ruiz
Janice Cawthorn
Norman W. Loney

Assessing the Possible Rangeland Management Methods for use by the Rosebud Sioux Tribe, Todd County, South Dakota.

August 11, 2004

Managers:

Anthony Brigantic | **Lewis E. Winstead, Jr.**

Team Members:

Walter Adams III | **Robert S. Patrick**

Alana M. Barnes | **Marissa L. Tuck**

Nathan Burgess | **Garry V. Wieneke, Jr.**

Mentors:

Janice Cawthorn
DEVELOP Langley Faculty Advisor
Phone: (757) 864-3834
Email: j.d.cawthorn@LaRC.nasa.gov

NASA Langley Research Center
4 Langley Blvd.
Building 647, Room 307
Hampton, VA 23681-2199

Michael Ruiz
National DEVELOP Program Manager
Phone: (757) 864-3738
Fax: (757) 864-7890
Email: m.l.ruiz@LaRC.nasa.gov

NASA Langley Research Center
4 Langley Blvd
Building 647, Room 301
Hampton, VA 23681-2199

Acknowledgements

We greatly acknowledge Dr. Norman Loney, Science Advisor, New Jersey Institute of Technology; Mr. Tom Spencer, Technology Advisor, University of Virginia; Mr. Mike Ruiz, National DEVELOP Program Manager; Miss Janice Cawthorn, Project Director, Hampton University; Miss Lindsay Maynard, DEVELOP Co-Director; Mr. Jonathan Gleason, DEVELOP Co-Director; James Rattlingleaf, Rosebud Sioux Advisor for their helpful criticism, guidance, and suggestions as advisors for this Research Project.

Table of Contents

Section
Page

Abstract

Rangeland management involves analyzing all human and natural factors affecting a grazing zone and then fabricating a plan that takes this data into account in order to maximize the output of the available grazing area. South Dakota's rangelands have a significant impact not only on their economy, but also on the people who reside there.

Our customers, the Rosebud Sioux, are in need of more efficient rangeland management techniques to solve issues including invasive species, overgrazing, soil erosion, and overall land degradation. This research project will enhance the customer's understanding of the science and current techniques involved in rangeland management. Gaining a modern insight into an age-old relationship (the bond between animals, land, and people) will prove invaluable to the people who reside on the reservation.

By researching the land surface composition in conjunction with Geographic Information Systems (GIS), valuable information can be obtained to improve these grazing practices. The GIS data that was collected ranges from vegetation health to digital elevation. This data was gathered from NASA missions such as Terra, Shuttle Radar Topography, and Landsat 7. These data sources were used to create normalized difference vegetation indices and biomass images and information. The Soil and Water Assessment Tool allowed stream flow, soil type and water contamination to be calculated. This hydrology model analyzes digital elevation, land cover, and soil content to help establish possible agricultural management scenarios. The outcome of the model along with enhanced GIS data will then be used to increase the effectiveness of rangeland management practices.

The Reservation endures a semi-arid climate, where drought is possible any given year; this area commonly receives hot summer temperatures providing little precipitation (Truman). "Overuse" by livestock or wildlife can cause the health of the grazing land to deteriorate (Boerboom).

Section 1
Introduction

In the grazing season of 2002, the Rosebud Sioux people faced the worst drought in recorded history. This resulted in a detrimental impact on the economy of the tribe, which compelled further research in rangeland management (Todey). Upholding respect and understanding for the land and people is an important concern; James Rattlingleaf put it best by stating, "we do not own the land, [but instead] the land owns us."

1.1 Goals and Objectives

Rangeland management is the primary concern of the Rosebud Sioux people and also the main focus and goal of this project. Rangeland management can be defined as gathering data about the effects of all human and natural factors affecting the available grazing area then analyzing that data to fabricate a course of action to maximize the output of the available grazing area (Judging South Dakota). As an extension of this definition, the project's goal can be subdivided into three main categories: gathering and integrating knowledge of the region's native plants, native and domesticated animals, and soil characteristics; analyzing this information and inputting it into a model and visualizations; and creating a rangeland management system for the Rosebud Sioux.

In order to accomplish these goals, several specific objectives have to be reached. These objectives include: identifying the native flora and fauna of Todd County; gathering data from NASA missions and Non-NASA organizations and then implementing this data into a model with predictive capabilities; utilizing the ERDAS 8.7 and ArcView 8.0 software packages effectively; understanding how to deliver an effective and educational speech to the Rosebud Sioux policy-makers; creating a clear and visually appealing presentation that will more effectively convey our ideas and suggestions.

1.2 Problem Statement

An efficient rangeland management system needs to be developed in order to help the Rosebud Sioux maintain self-sufficiency. NASA and non-NASA data sources will be analyzed and interpreted, along with the use of a model with predictive capabilities to determine an effective rangeland management plan for the Rosebud Sioux Reservation.

Section 2
Background

To fully understand the community concern that this project addresses, it is important to consider the history and general characteristics of the area and people involved.

2.1 Anthropological History

In the past two centuries, the Sioux nation of South Dakota has gone from approximately 75,885 square miles down to a dwindling 1,442 square miles (Rosebud Sioux Tribe official website). This ninety-seven percent decrease in overall land area has caused an increased demand for better rangeland management techniques. While trying to maintain their cultural heritage and identity, the Sioux have struggled to preserve their way of life and establish self-sufficiency. Rangeland management is an effective tool to assist the reservation in the aspects of preserving cattle ranching as their primary source of income.

Another important factor that we must consider is the scientific background of our customer and audience. It is of utmost precedence that our presentation is visually appealing; this will allow the results to be described in general terms and understood by a less technical audience. The Sioux maintain an incredible level of respect and bond with their land; with NASA mission's data, new information will be combined with time-tested techniques to discover the best overall method of rangeland management.

2.2 Effects Due to Climate

Todd County is located in a region where hot summer temperatures and limited precipitation can be prohibiting factors in agricultural efficiency. The possibility of a drought occurring in any given year can greatly impact the economic and socioeconomic aspects of life on the reservation. Rattlingleaf explained the importance of the land when he said, "The land is our main source of income and livelihood." According to recent recorded history, the most severe droughts the tribe has faced have occurred in 1974, 1976 and 2002 (Todey). The drought in 2002 was the most destructive than previous droughts, because the amount of precipitation that occurred in the grazing season reached an all time low. As shown in Appendix A, the precipitation is highly monitored and is always a primary concern of land–dependent cattle ranchers.

The prairie lands offer little resistance to high winds and drifting snow during blizzards, which regularly destroy property and kill livestock. Similarly to blizzards, overgrazing and wildfires can have devastating effects on property. While wildfires can devastate homes and grazing pastures, they have been known to provide natural protection against invasive species. The sensitivity of the land is also a factor. If the land has been overgrazed there is often little chance for spring revitalization (Truman).

Section 3
Technical Approach

This portion of the paper introduces a concise description of Todd County, and a description of the project's progress. It is important to understand Todd County's water quality, soil characteristics, land surface, vegetation, wildlife, and grazing to better enable the process for producing an effective rangeland management system. There is much in common in terms of rangeland areas, however 'regional differences need to be addressed at a community level (Aussie Journal).' Data acquisition, project methodology, and model application will provide a chronological description as to how the conclusions were formulated.

3.1 Description of Area

Todd County, which is located in south central South Dakota is home to the Rosebud Sioux Tribe. There are many aspects that contribute to the uniqueness of the reservation. The water quality, soil quality and land cover are just some of the variables that describe the complexity of range management issues. The following is a more thorough discussion of each concern.

3.1.1 Water Quality

Water is the basis of all living things here on Earth (Water). Throughout the reservation, the rosebud Sioux incounter problems with water quality and inadequate supply (Rosebud Sioux Tribe Community). The Ogallala and Arikaree aquifers are the main source of water for the reservation; used almost exclusively used for irrigation, municipal, and domestic water supplies (Carter). The quality of this water is acceptable for irrigation, but in most places in Todd County, including the Ogallala aquifer, it does not meet the US Environmental Protection Agency drinking water standards (Dennehy). In looking at the quality of the water we have identified that there are two types of contamination possibilities; point and non-point contamination.

Grazing, which is a main source of income on the reservation, can also cause damage to the water quality. Much of the soil used on the grazing lands contains fertilizers which runoff and contaminate the water. Along with soil runoff, it has been noted that in Todd County, pollutants also include harmful chemicals. Chemicals such as arsenic have also been linked to contaminating the groundwater along Whitewood Creek (Iles). Some point sources of contamination include herbicides used in killing invasive species, pesticides and solid and animal waste (Paque). This problem is commonplace throughout the reservation (Rosebud Sioux Tribe Community Environmental Profile). Many residents use poorly constructed wells, which contain dissolved solids/salinity, fluoride, chloride, and sulfate (Dennehy). According to the High Plains Regional Ground Water Study, "Agriculture is the primary industry on the Rosebud Reservation and the key to full development of the industry is water." The absence of a reliable water source

causes a decrease in livestock production on the reservation (Rosebud Sioux Tribe

3.1.2 Soil Quality

There are many different types of soil in Todd County, South Dakota (Physical Properties of the Soil). According to a Soil and Site information report done by the National Resources Conservation Service, there are approximately 21 different types of soil on the Rosebud Reservation. To classify these difference types of soil wind erodibility groups are formed, classifying each group in accordance to susceptibility to wind erosion (Physical Properties of the Soil). These soils are grouped and arranged in order of most susceptible to wind erosion to least susceptible (Physical Properties of the Soil).

1. Coarse sands, sands, fine sands, and very fine sands.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and sapric soil material.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams.
4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35% clay.
5. Noncalcareous loams and silt loams that ate less than 20% clay and sandy clay loams, sandy clays, and hemic soil material.
6. Noncalcareous loams and silt loams that are more than 20% clay and noncalcareous clay loams that are less than 35% clay.
7. Silts, noncalcareous silty clay loams that are less than 35% clay, and fibric soil material.
8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Soil erosion is an important issue to keep in mind when focusing on rangeland management. The loss of topsoil affects the ability of the soil usefulness of the soil and its ability to sustain future life (Ebert). In any management plan it is important to identify any risks associated with soil erosion and potential for recovery (Ebert).

3.1.3 Soil Classification

Good grazing practices and land management techniques are crucial to maintain a ‘soil cover’ that will prevent wind erosion and blowouts (Judging South Dakota). There are many different types of soil in Todd County; using the soil susceptibility listing above provided by the National Resources Conservation Service a grouping of soil types been formed.

1. **Sands** include group one and two from the NRCS breakdown. Precipitation does not run off, except in extreme cases (Judging South Dakota). Potential natural plant cover includes of sand bluestem, prairie sandreed, and swithgrass. Grasses such as needleandthread, sand dropseed, and blue or hairy grama occur less frequently (Judging South Dakota).

2. **Sandy** soils include group three from the NRCS breakdown. Water intake rate is moderate to rapid, and available water capacity is moderately high (Judging South Dakota). Potential natural plant cover includes of sandreed, little bluestem, sand or big bluestem, and needleandthread (Judging South Dakota).

3. **Silty** soils include group four from the NRCS breakdown. This soil is moderately well draining, with high water capacity and positive 'soil-water-plant relationships (Judging South Dakota).' Potential natural plant cover includes of western wheatgrass and green needlegrass are predominant

4. **Clayey** soil include group five and six from the NRCS breakdown. Runoff is generally slow, and with marginal soil saturation. Potential natural plant cover includes western wheatgrass and green needlegrass (Judging South Dakota).

5. **Dense clay** soil include group six and seven from the NRCS breakdown. Runoff is generally very quick, and with minimum soil saturation. Potential natural plant cover is western wheatgrass and green needlegrass (Judging South Dakota).

3.1.4 Invasive Species

An invasive species that is present on reservation is the Russian olive. This plant can grow up to thirty feet, and resembles a small tree. Like most invasive species, the main threat of Russian olive, is its ability to oust native species (Muzika). The Russian olive is incredibly rugged, and has the ability to take root in areas of poor soil quality. The plant grows most often in fields and along streams. The plant also has few predators. Besides birds, most animals do not find Russian Olive as resource for shelter, or food (Muzika).

Another noxious plant that plagues the Sioux is the Leafy Spurge also known as the *Euphorbia esula*. Similar to the Russian olive, the leafy Spurge multiplies rapidly and spreads quickly (Lorenze). The plant is not eaten by livestock, and typically grows in non-crop areas (Lorenze). The Leafy Spurge and the Russian olive are two examples of unwanted invasive species; these plants add another obstacle in formulating an effective rangeland management system.

Wildfire, a concern of property damage, actually helps counter these invasive species. Many native grass species grow back quickly after a fire has swept through the grassland; this is not true for the invasive species (panda). The invasive species has been able to survive due to wild fire repression. (http://www.panda.org/news_facts/education/virtual_wildlife/wild_places/grasslands.cfm).

3.1.5 Land Cover

The land surface of South Dakota consists of approximately thirty million acres of grasslands, which provides a very significant amount of agricultural income within the

state. Grasses and other plants found in Todd County, South Dakota, are the foundation of a food chain that supports a variety of species of wildlife as well as livestock. Grasslands are generally referred to as a "renewable resource," when they are "managed" properly (Boerboom). There are various types of vegetation that can be found in Todd County including the needleandthread, green needlegrass, western wheatgrass, slender wheat grass, blue grama, prairie junegrass, little bluestem, prairie sandreed, stonyhills muhly, and buffalo grass. This specific area is generally referred to as a mixed grass community with soils formed from sandstone, siltstone, and shales on uplands to about 3,600 feet (South Dakota Rangelands: More than a Sea of Grass). Western wheatgrass and green needlegrass prevail as the dominant grass found in this rangeland area where seventy-five to eighty percent of the land is still considered rangeland.

Since the major economic profession of the Rosebud Sioux Reservation is cattle ranching and farming, adequate protection of the rangeland is desired to maintain an ongoing production of cattle within the mixed grass grazing area. State Agricultural Experiment Stations and Soil Conservation Service Plant Material Centers have suggested a variety of grasses that will aid in the protection of the grazing lands. Such suggested grasses include Intermediate Wheatgrass, Smooth Bromegrass, Bonilla, and Sideoats Grama, which are excellent in the area of erosion control. Cottonwood grass, which is highly tolerant to drought, is also suggested along with several other grasses that contribute to healthier land by providing high values of seed and forage production. (http://agbiopubs.sdstate.edu/articles/EC890.pdf)

3.1.6 Animals

Todd County is home to a countless number of animals. These animals can be divided into two different categories wildlife and grazing animals:

The wildlife animals include bison, antelope, coyote, and prairie dogs. The American Buffalo (*Bison bison*). The eradication of Buffalo was seen as a way to weaken the Native Americans since they depended on it as a major source of food (American Buffalo). The animals graze primarily on grass and are most common in South Dakota and Montana.

The two grazing animals of Todd County are the pronghorn and cattle. The people of Todd County depend on these animals to fuel their local economy. Pronghorns belonging to the family *Antilocapridae*, are common to South Dakota. The Pronghorn is the fastest animal in the United States traveling at 54 miles per hour. Cattle are the largest part of the local Native American economy. Cattle graze on grass in pastures, and provide the Native Americans with food, drink, and money. In total there are approximently 60000 cows in Todd County South Dakota (USDA-NASS). The cattle are used for either beef or dairy, and in some cases they can even be trained to pull carts as oxen (Cattle). With the myriad of benefits that the cattle provide the Native Americans with, it is obvious why their loss is devastating loss to the people of Todd County.

3.2 Data Acquisition

3.3 Methodology

Works Cited

Boerboom, Justin. "Grasslands." SDCONSERVATION.ORG. 13 June 2004. SDACD. 07 July 2004. <www.sdconservation.org/grassland/index.html>

Turman, Kristi. "Hazard Vulnerability." South Dakota Office of Emergency Management. 24 June 2004. DEM. 25 June 2004. <http://www.state.sd.us/dps/sddem/mitigation/vulnerability.htm>

Todey, Dennis, PhD. South Dakota Climate and Weather. 1997. South Dakota State University. 18 June 2000 <http://climate.sdstate.edu/w_info/que/ncdcmonthlynew.asp#>.

Judging South Dakota Rangelands for Livestock and Wildlife Values. 2001. 1-5.

Ebert, Don, et al. USDA and EPA. Landscape Indicator Interface with Hydrologic Models. Las Vegas: EPA Office of Research and Development, 2000.

Compiled History of the Sioux. 1998. Rosebud Sioux Tribe. 9 July 2004 <http://tradecorridor.com/rosebud/rosebud.htm>.

'Drought'. 2004. Dictionary.com. 12 July 2004 <http://dictionary.reference.com/search?q=drought>.

Rosebud Sioux Tribe Community Environmental Profile. 1998. Mni Sose Intertribal Water Rights Coalition. 12 July 2004 <http://www.mnisose.org/profiles/rosebud.htm>.

Routledge, Denise, and Dan Stuart. "Water: Essential for Existence." Explore 1998. 12 July 2004 <http://www.explorepub.com/articles/water.html>.

Dennehy, Kevin. High Plains Regional Ground Water (HPGW) Study. 15 Jan. 2004. USGS. 12 July 2004 <http://webserver.cr.usgs.gov/nawqa/hpgw/HPGW_home.html>.

"Physical Properties of the Soil." 2003

Bossany, Vince. ESPN Outdoors. 2004. ESPN. 12 July 2004 <http://espn.go.com/outdoors/conservation/s/c_fea_BASF_salt_cedar_NM_VB.html>.

Kurtenbach, Darwin, and Ron Moehring. Salt Cedar (Tamarix) Declared a State Noxious Weed. South Dakota News. 12 July 2004 <http://www.state.sd.us/news/fullnews.asp?Q=4175>.

"Rangeland Soil Quality-Wind Erosion." Washington D.C.: USDA, 2001.

Johnson, James R., and Michael L. Stirling. 'Judging South Dakota' Rangelands for livestock and Wildlife Values. Aug. 2001. South Dakota State University. 13 July 2004 <http://agbiopubs.sdstate.edu/articles/EC914.pdf>.

Lorenze, Russell. Leafy Spurge. 4 Feb. 2004. Wisconsin Department of Natural Resources. 12 July 2004 <http://www.dnr.state.wi.us/org/land/er/invasive/factsheets/spurge.htm>.

Leco, Mike. South Dakota Travel. 12 July 2004 <http://www.usatourist.com/english/places/southdakota/>.

Prairie Dogs. 1996. Desert USA. 12 July 2004 <http://www.desertusa.com/dec96/du_pdogs.html>.

American buffalo, (Bison bison). Jan. 1998. 12 July 2004 <http://species.fws.gov/species_accounts/bio_buff.html>.

Cattle. 3 July 2004. Wikipedia. 13 July 2004 <http://en.wikipedia.org/wiki/Cattle>.

Babbitt, Bruce. Fight Fire with Fire. 1 Sept. 1998. Commonwealth Club. 16 July 2004 <http://www.wildfirenews.com/fire/articles/babbitt.html>. \

Paque, Mike . South Daktoa Ground Water Conditions. Ground Water Protection Council. 16 July 2004 <http://www.gwpc.org/gwreport/Acrobat/South%20Dakota.pdf>.

Muzika, Rose-Marie . Russian-Olive. Plant Conservation Alliance. 16 July 2004 <http://www.nps.gov/plants/alien/fact/elan1.htm>.

Lewis , Kristi. Water Pollution. 28 Dec. 2002. South Dakota Conservation. 16 July 2004 <http://www.sdconservation.org/water/pollution.html>.

Carter, Janet M. Water Resources of Mellette and Todd Counties, South Dakota. 15 May 2003. USGS. 16 July 2004 <http://water.usgs.gov/pubs/wri/wri984146/>.

Iles, Derric L. Ground Water Contamination In South Dakota. South Dakota Department of Conservation. 16 July 2004 <http://www.northern.edu/natsource/WATER/Contam1.htm>.

Rosebud Sioux Tribe official website. 2003. Rosebud Sioux. 30 June 2004. <http://www.rosebudsiouxtribe-nsn.gov/>

Appendices

- **Appendix A**

Rainfall Data
Mission
Station #SD5620
Todd County, SD

	Monthly Rainfall Totals in Inches							Monthly Weighted Totals				
Year	March	April	May	June	July	Aug.	Sept.	June	July	Aug	Sept.	Oct.
1980	1.29	0.62	1.43	2.37	0.64	3.66	0.49	6.82	10.59	8.09	14.63	9.43
1981	1.05	0.43	4.44	2.56	4.11	2.51	0.87	15.23	16.99	21.89	18.31	11.74
1982	1.07	0.97	7.80	5.31	3.65	2.81	1.69	26.41	32.50	29.37	21.04	14.34
1983	1.69	1.96	4.82	3.85	3.46	1.18	1.21	20.07	23.15	22.90	14.31	9.45
1984	1.15	2.97	2.54	2.00	3.94	0.54	1.17	14.71	14.05	18.36	11.50	8.53
1985	0.80	1.94	0.37	1.30	2.82	1.53	2.02	5.79	6.58	11.43	11.53	11.94
1986	2.15	3.78	2.41	3.52	3.70	2.47	3.14	16.94	19.16	20.55	18.33	18.06
1987	2.87	0.57	4.96	0.80	3.68	1.54	0.61	18.89	12.89	17.60	12.78	8.59
1988	0.83	1.02	4.72	3.31	2.41	0.57	1.56	17.03	20.39	18.57	9.84	8.23
1989	0.80	1.00	1.16	1.63	1.57	1.60	4.95	6.28	8.21	9.13	9.57	19.62
1990	1.84	1.50	3.36	3.21	5.89	1.32	0.27	14.92	17.85	27.45	18.95	9.34
1991	0.78	2.70	7.22	5.78	0.70	1.45	0.23	27.84	34.48	20.88	11.53	4.29
1992	1.08	0.57	0.34	4.99	5.18	1.45	1.58	3.24	16.22	25.86	19.70	12.82
1993	0.56	2.81	2.03	3.93	3.08	0.99	1.77	12.27	18.66	19.13	13.06	10.37
1994	0.22	2.95	0.58	3.83	3.00	4.80	0.82	7.86	15.60	17.24	24.23	15.06
1995	1.12	3.19	6.04	4.26	1.50	1.24	1.07	25.62	28.05	19.06	10.98	7.19
1996	0.36	1.00	5.67	0.89	0.51	1.52	4.76	19.37	15.01	8.98	6.47	17.83
1997	0.11	3.93	2.43	4.71	3.81	1.44	1.11	15.26	22.92	23.28	16.65	10.02
1998	2.04	0.62	3.00	5.31	5.49	1.99	0.99	12.28	22.55	30.09	22.26	12.44
1999	0.56	3.98	4.33	5.38	2.01	2.61	4.15	21.51	28.78	21.12	17.23	19.68
2000	0.53	2.90	6.18	4.42	3.14	0.81	0.53	24.87	28.52	24.44	13.13	6.35
2001	0.77	4.81	2.74	3.62	3.64	0.23	1.89	18.61	21.15	20.90	11.59	9.77
2002	0.98	1.48	1.90	0.33	0.67	0.56	3.50	9.64	6.27	4.57	3.35	12.29